Internal Herniation in Pregnancy After Gastric Bypass

A Systematic Review

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OBJECTIVE: To assess maternal and fetal outcomes of pregnancies complicated by internal herniation after Roux-en-Y gastric bypass.

DATA SOURCES: Articles were identified through searches in online databases (ClinicalTrials.gov, MEDLINE, EMBASE, PubMed, and Google Scholar) from January 1980 to March 2015 for the following terms: [gastric bypass OR bariatric surgery] AND [pregnancy] AND [complication OR herniation OR obstruction]. Reference lists of relevant articles were hand-searched. Additionally, we searched our own hospital's obstetric database for cases of internal herniation after Roux-en-Y gastric bypass.

METHODS OF STUDY SELECTION: Only articles in English and studies in humans were selected. Cases of internal herniation outside of pregnancy or internal herniation without a history of Roux-en-Y gastric bypass were excluded. Of 384 articles identified by the initial search, 22 were retained for further analysis.

TABULATION, INTEGRATION, AND RESULTS: All retrieved articles were case reports or case series. There were no interventional studies. We retrieved 47 cases from the literature and five cases from our own database. The mean gestational age at diagnosis was 28.4±7.3 weeks. All women presented with abdominal pain. Nausea and vomiting were present in only 65%. Ultrasonography and laboratory results are usually noninformative, and computed tomography or magnetic resonance imaging confirmed the diagnosis in only 75% of cases. Nine of 52 women (17.3%) required bowel resections. There were two maternal deaths and three perinatal deaths, all in women treated later than 48 hours after onset of the symptoms.

CONCLUSION: Internal herniation complicating pregnancy after Roux-en-Y gastric bypass typically presents with subtle signs in the third trimester of pregnancy. Timely recognition and early surgical intervention are associated with a reduced risk of bowel ischemia and maternal and fetal adverse outcomes.

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In the Western world, the prevalence of obesity has doubled since the 1980s. In 2014, more than 1.9 billion adults were overweight (body mass index [BMI, calculated as weight (kg)/[height (m)]^2] 25 or greater) and 600 million were obese (BMI 30 or greater), more than 50% being women.[1] During pregnancy, obesity leads to increased risks for the mother (eg, hypertension, preeclampsia, gestational diabetes, and cesarean delivery) and the fetus (eg, structural anomalies, stillbirth, preterm delivery, macrosomia, and birth trauma).[2]

In a nonpregnant population, bariatric surgery reduces the risk of obesity-related morbidity resulting from sustained weight loss and an intrinsic metabolic effect.[3,4] As a consequence, weight reduction surgery has boomed over the past two decades in female adolescents and women of reproductive age. Observational studies have shown that women who underwent bariatric surgery before pregnancy have better maternal pregnancy outcomes than nontreated obese women.[5] However, pregnancies after bariatric surgery are still

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more complicated than pregnancies in a nonobese population as a result of persistent obesity, micronutrient deficiencies, and postoperative complications.[6]

One of the complications well known by bariatric surgeons is small bowel obstruction resulting from internal herniation, which has a lifetime incidence of up to 10% in patients who underwent Roux-en-Y gastric bypass. Typical signs and symptoms are presented in Box 1. The physiologic changes of pregnancy can mask its symptoms, leading to a delay in treatment and poor outcomes.[7]

The aim of this article is to assess maternal and fetal outcomes of pregnancies complicated by internal herniation after Roux-en-Y gastric bypass.

SOURCES

This is a systematic review of the literature following the Meta-Analyses and Systematic Reviews of Observational Studies guidelines. We focused our search on articles describing women who underwent Roux-en-Y gastric bypass and who were subsequently diagnosed with internal herniation during pregnancy. We systematically searched ClinicalTrials.gov, MEDLINE, EMBASE, PubMed, and Google Scholar (limited to the first 200 hits) from January 1980 to March 2015 for the following terms: (gastric bypass OR bariatric surgery) AND (pregnancy) AND (complication OR herniation OR obstruction). We did not have contact with the authors. Only articles in English and studies in humans were selected. Only full-text articles were included; conference abstracts were excluded. A more extensive description of the methodology is available in Appendix 1, available online at http://links.lww.com/AOG/A800. Reference management was done with Endnote X6. Two reviewers (V.V., M.B.) independently screened the titles and abstracts of the search results to determine whether they were eligible for inclusion. The full texts of eligible articles or those for which eligibility was uncertain were reviewed. Reference lists of relevant articles were hand-searched to identify articles not captured by the electronic search.

Box 1. Signs and Symptoms of Uncomplicated Small Bowel Obstruction Resulting From Internal Herniation

- Nausea and vomiting
- Abdominal pain
- Constipation
- Abdominal distension
- Tympanic abdominal percussion
- Hyperperistalsis on abdominal auscultation
- Epigastric pain on palpation

STUDY SELECTION

We retrospectively identified all pregnancies diagnosed with internal small bowel herniation after Roux-en-Y gastric bypass at the University Hospitals Leuven, Leuven, Belgium, between January 1, 2008, and July 1, 2015, through a search of our electronic obstetric database. This study was reviewed by the ethical committee of the University Hospitals Leuven and exempted from further review because it included only retrospective data. We included patients followed and treated at our center as well as patients referred because of complications. For each patient, we retrieved symptoms at initial presentation, eventual use of imaging techniques, and laboratory findings. All patients underwent surgical intervention, which confirmed the diagnosis and allowed treatment. For all patients, we collected immediate pregnancy outcome and maternal and infant follow-up.

For all cases retrieved, we extracted data using a standardized data extraction form including the following variables: gestational age at presentation, time interval between Roux-en-Y gastric bypass and internal herniation, presenting symptoms, imaging methods, type of surgical intervention, further pregnancy complications, gestational age at delivery, infant and maternal survival, and long-term complications. We assessed whether early diagnosis and intervention (within 48 hours after onset of symptoms) were associated with better maternal and fetal outcomes than late intervention (48 hours or later after onset of symptoms).

Statistical analysis was done using Prism for Windows 5.00. Descriptive statistics are provided. Two groups were compared using Mann-Whitney test. Categorical data were compared using Fisher's exact test. A P value $<.05$ was considered statistically significant. All tests were two-sided.

RESULTS

The literature search yielded 384 citations (SDC1). Our search of ClinicalTrials.gov did not yield any additional completed studies. All titles and abstracts were screened for eligibility. After removal of duplicates, 22 articles were retained (Fig. 1).[8–29] All retained articles were case reports, case series, or retrospective cohort studies. Cross-referencing was done to detect multiple publication. Study quality was assessed using criteria published by the Institute of Health Economics.[30]

We identified five patients from our local population, all of whom underwent surgery. We are not aware of patients treated conservatively in that time period. Details are provided in Table 1. All five women presented in the third trimester of gestation

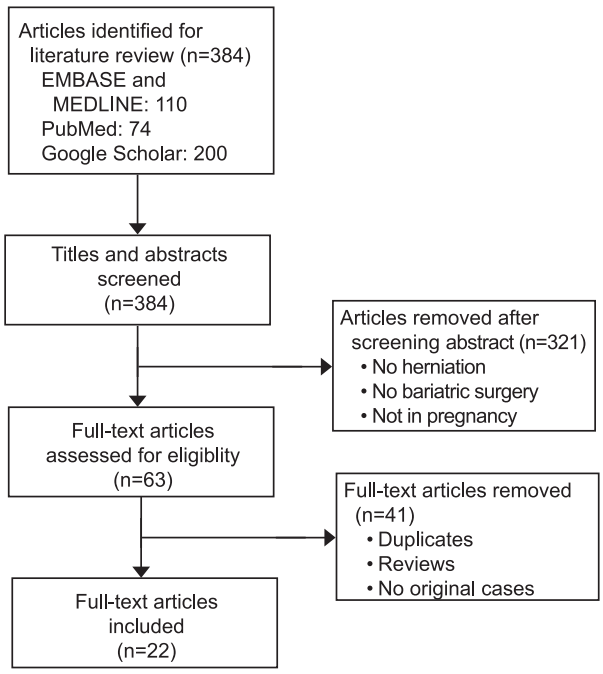

Fig. 1. Systematic literature review.
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with severe epigastric pain as the predominant symptom. One patient had associated nausea and vomiting. Magnetic resonance imaging (MRI) was contributive in only two of the five patients. In two patients, laparoscopy was performed based on a strong clinical suspicion, despite normal imaging or a lack of imaging. In case 4, the decision for surgery was based on nonreassuring fetal status on admission. This patient initially was diagnosed elsewhere with acute pancreatitis (acute abdominal pain and strongly elevated lipase level; Table 2) and referred to us only 3 days later as the patient deteriorated despite adequate conservative management. On arrival, a nonstress test showed a preterminal fetal heart rate pattern (complete loss of variability and spontaneous decelerations). An urgent cesarean delivery was performed under epidural analgesia. On inspection of the abdomen, we found distended, ischemic small bowel loops resulting from an internal herniation of the common loop through the mesenteric defect. The herniation obstructed the biliary loop, which caused the retrograde pancreatitis. The herniation was reduced, and 3 m of necrotic bowel was resected. The child did well, and the mother recovered rapidly but has persistent short bowel syndrome, which is treated conservatively. In case 5, the patient was diagnosed correctly and treated by laparoscopy elsewhere, but a uterine perforation occurred during the surgery. This led to preterm prelabor rupture of the membranes and subsequent chorioamnionitis and placental abruption. The neonate had sepsis, a prematurity-related grade II intraventricular hemorrhage, and grade II retinopathy of prematurity but is developing well, now at the age of 1 year. Despite uneventful surgery and postoperative course in the three other patients, two still delivered preterm.

Forty-seven cases of internal herniation complicating pregnancy after Roux-en-Y gastric bypass were identified from the literature search, forming a total of 52 cases including our five patients. Of note, all cases were published between 2004 and 2015. A table detailing all individual cases is available on request. On average, study quality was moderate with many outcome variables missing. Details of quality assessment are available on request. Mainly information on BMI, birth weight, and long-term outcomes was lacking. Crossreferencing was done to reduce the risk of publication bias.

Of all 52 patients, the mean gestational age at diagnosis of herniation was 28.4±7.3 weeks. The median time interval between Roux-en-Y gastric bypass and internal herniation was 24 months (range 8–108 months). Mean maternal BMI at the start of pregnancy was 26.3±2.5 (data available for only 14 patients).

Information on clinical symptoms and imaging techniques was available for 34 patients, all of which presented with abdominal pain. Twenty-two women (64.7%) had associated nausea or vomiting. Abdominal ultrasonography (n=15), radiography (n=6), computed tomography (n=15), and MRI (n=5) were used as diagnostic imaging. Six women (17.6%) were taken for surgery on a clinical suspicion of internal herniation, five of whom did not undergo any imaging and one with a normal abdominal ultrasonogram. Results of imaging tests are presented in Table 3. Of note, abdominal ultrasonography was normal in all cases and abdominal computed tomography or MRI provided a correct diagnosis in 75% of patients. Information on laboratory results on admission was available for 31 women. Twenty-two had normal results on admission (71.0%) and nine had leukocytosis or elevated lipase or elevated C-reactive protein (29.0%).

Surgical details and intraoperative findings are described in Table 4. Time between the onset of symptoms and surgery was available for 33 cases (Table 5). Median delay to surgery was 48 hours (range 1 hour to 6 weeks). Twelve women were taken to surgery within 48 hours after the onset of symptoms (36.4%), and 21 had surgery delayed for 48 hours or more (63.6%). Only 1 of 12 patients (8.3%) with early surgery required bowel resection compared with 7 of 21 patients (33.3%) in the delayed group. In the total

Table 1. Clinical Outcomes for Five Cases of Internal Herniation During Pregnancy in Our Local Population

Case No.	GA at Presentation (wk)	Time Since RYGB	BMI (kg/m^2)	Symptom(s)	Technical Investigations	Time to Surgery (h)
1	28	18 mo	23.3	Epigastric pain	US: normal Gastroscopy: normal MRI: obstruction	42
2	25	18 mo	25.3	Epigastric pain	US: normal MRI: normal	96
3	34	13 mo	26.5	Epigastric pain	US: normal MRI: herniation	Less than 48
4	33	7 y	25.0	Epigastric pain, vomiting	US: normal	72
5	26	6 y	28.2	Epigastric pain	None	Less than 24

GA, gestational age; RYGB, Roux-en-Y gastric bypass; BMI, body mass index; US, ultrasound; MRI, magnetic resonance imaging; A&W, alive and well; PROM, premature rupture of membranes; IVH, intraventricular hemorrhage; ROP, retinopathy of prematurity.

cohort of 52 patients, there were two maternal deaths (3.8%) and three perinatal deaths (5.8%). All occurred in the delayed surgery group. The maternal deaths were secondary to sepsis resulting from massive bowel necrosis. In one of these cases, the fetus also died. The two other perinatal deaths were the result of prematurity in neonates born at 24 and 26 weeks of gestation.

Twenty-three women delivered during the hospital admission for the herniation (44.2%): 19 underwent a cesarean delivery during exploratory laparotomy (gestational age range 26–38 weeks). Four women went into labor immediately postoperatively at 24, 26, 26, and 34 weeks of gestation, respectively.

Twenty-nine women did not deliver at the time of admission. Data on pregnancy outcome were available for only 14 of these: 11 had term delivery (11/14 [78.6%]), one underwent a cesarean delivery at 32 weeks of gestation for preterm labor with nonreassuring fetal status in a twin pregnancy, one delivered by cesarean at 33 weeks of gestation for nonreassuring fetal status, and one went into spontaneous labor at 35 weeks of gestation. Although we were unable to calculate the gestational age at delivery for the whole cohort as a result of missing data, at least 19 women (38.8%) delivered before 37 weeks of gestation and at least 16 (32.7%) delivered at term.

DISCUSSION

We here describe five cases of internal herniation during pregnancy after Roux-en-Y gastric bypass and retrieved another 47 cases from the literature. Because we retrieved only case reports and small case series, we could not assess whether the incidence of internal herniation in pregnancy is any different from that in the nonpregnant population. However, the fact that most cases occurred in the third trimester suggests that the growing uterus, by displacing the bowel, may play a role in the pathophysiology and would therefore potentially increase the incidence in pregnancy.

The incidence of internal herniation after Roux-en-Y gastric bypass varies in the literature between 0% and 15%. There are three anatomical sites where an internal hernia after Roux-en-Y gastric bypass may occur: through the transverse mesocolon defect (seen after open Roux-en-Y gastric bypass procedures with retrocolic positioning of the Roux limb), through the intermesenteric jejunojejunostomy defect, or, most frequently, through the space between the mesentery of the Roux limb and the transverse mesocolon (Petersen's space; Fig. 2).[31] Internal herniation seems to be more frequent in patients with rapid excess weight loss.[32] Prevention of internal herniation could theoretically be achieved by closure of the mesenteric defect at the time of bariatric surgery. However, in practice, after an important weight loss episode, these defects appear to be present over time, even if primarily closed.

The significant time delay between onset of obstructive symptoms and surgery (48 hours) in this series suggests that internal herniation, although well known by bariatric surgeons, is poorly recognized by

Surgical Findings	Pregnancy Complications	GA at Birth (wk)	Birth Weight (g)	Infant Outcome	Maternal Outcome
Laparoscopy, Petersen hernia, no bowel ischemia	Preterm labor	35	2,260	A&W	A&W
Laparoscopy, Petersen hernia, no bowel ischemia	—	39.4	3,000	A&W	A&W
Laparotomy, hernia jejunojejunostomy defect, no bowel ischemia	Preterm labor	34.5	2,240	A&W	A&W
Laparotomy, Petersen hernia, Cesarean delivery+bowel resection 300 cm: necrosis	—	33.7	2,060	A&W	Short bowel syndrome
Laparoscopy, Petersen hernia, no bowel resection, uterine perforation	Preterm PROM chorioamnionitis abruption	26.4	930	Grade II IVH, grade II ROP, sepsis	A&W

obstetric care providers. Indeed, although the symptoms are the same as outside of pregnancy, they are often nonspecific (abdominal pain and vomiting; Box 1) and occur very commonly in the third trimester of normal pregnancy. Similar treatment delays have been reported for intestinal obstruction in pregnancy resulting from other causes (eg, volvulus, intussusception).[7,28]

Early diagnosis is further complicated by a lack of striking clinical or laboratory findings in a majority of cases and a sensitivity of computed tomography and MRI of only 75%. Moreover, in some cases, care providers were reticent to use imaging as a result of the presence of the pregnancy. There is nevertheless sufficient data to support the relative safety of conventional imaging in pregnancy, especially if the mother is at risk of serious complications.[33] In case of suspected internal herniation, abdominal ultrasonography might reveal dilated small bowel loops and intraabdominal fluid and can exclude other causes of abdominal pain (such as cholecystolithiasis). Of note, however, abdominal ultrasonography was normal in all cases we retrieved. As such, it might be more useful in ruling out other conditions than in confirming a diagnosis of internal herniation. Abdominal radiography can show dilated bowel loops or intraabdominal air after bowel perforation. Computed tomography or MRI may show the site of obstruction. However, negative radiologic findings cannot exclude an internal herniation and, in women with ongoing abdominal pain, urgent diagnostic laparoscopy or laparotomy is recommended and imaging should not delay ongoing care. Indeed, although in the nonpregnant patient, conservative, nonsurgical management of obstruction resulting from internal herniation can be considered for the first 48 hours in the absence of signs of bowel ischemia,[34] we are reluctant to consider such conservative management in the nonpregnant woman. This is supported by the fact that, although the present study could not show a statistically significant difference between the early (less than 48 hours) and late

Table 2. Laboratory Results on Admission

Laboratory Test	Normal Range	Case 1	Case 2	Case 3	Case 4	Case 5
Haemoglobin (g/dL)	12.0–16.0	11	11.1	12.7	12.4	9.6
White blood cell count ($\times 10^9$/L)	4.00–10.00	12.29	9.76	7.59	11.02	8.8
Neutrophilic count ($\times 10^9$/L)	2.5–7.8	10.21	6.91	5.01	8.91	5.54
C-reactive protein (mg/L)	≤5.0	3.9	7.2	0.5	291.8	<5
AST (units/L)	≤32	19	13	15	20	20
ALT (units/L)	≤31	14	6	10	12	10
Lipase (units/L)	13–60	36	16	NA	552	162

AST, aspartate transaminase; ALT, alanine transaminase; NA, not available.

Table 3. Imaging Findings and Their Results in 34 Pregnant Women With Internal Herniation After Roux-en-Y Gastric Bypass

Imaging Test	Total	Result Normal	95% CI (%)
Abdominal ultrasonography	15	15 (100)	100–100
Abdominal radiograph	6	4 (66.6)	29–100
CT or MRI	20	5 (25)	6–44
Upper endoscopy	4	3 (75)	33–100

CI, confidence interval; CT, computed tomography; MRI, magnetic resonance imaging.
Data are n or n (%) unless otherwise specified.

(48 hours or greater) intervention groups (probably as a result of a lack of power), others have shown increased morbidity when surgery is delayed.[35] Moreover, in the pregnant woman, the obstetric risks (preterm labor, cesarean delivery, fetal risks) add to the baseline risk of bowel necrosis and perforation. An early surgical approach is also endorsed by others.[36]

We should warn that two factors may have led us to overestimate the severity of the disease. First, our hospital serves as a referral center, and it could well be that only the more complicated cases were referred to us. Second, because the majority of the cases included in the literature review are derived from case reports, rather than cohort studies, publication bias may have played a role. The largest case series in the review[29] reported lower maternal and fetal morbidity than the overall systematic review.

In conclusion, pregnant women who have previously undergone Roux-en-Y gastric bypass should be considered high-risk obstetric patients. Follow-up and treatment are ideally done in conjunction with a bariatric team. If internal herniation is suspected, surgical treatment should proceed as soon as possible to prevent adverse maternal and fetal outcomes. In a third-trimester pregnant woman with a history of a Roux-en-Y gastric bypass who presents with nonspecific findings of abdominal pain, with or without nausea and vomiting,

Table 4. Surgical Details in the Cohort of Women Undergoing Surgery During Pregnancy for Internal Herniation After Roux-en-Y Gastric Bypass (N=52)

Surgical Details	Total
Type of surgery	
Laparoscopy only	20 (38.5)
Laparotomy only	27 (51.9)
Laparoscopy converted to laparotomy	5 (9.6)
Bowel resection	9 (17.3)
Concomitant cesarean delivery	19 (36.5)
Location of herniation	
Petersen's hernia	24 (46.2)
Jejunojejunostomy mesenteric defect	17 (32.7)
Both Petersen and jejunojejunostomy	1 (1.9)
Mesocolon mesenteric defect	2 (3.8)
Not specified	8 (15.4)

Data are n (%).

Table 5. Maternal and Fetal Outcomes in 33 Women Undergoing Early (Less Than 48 Hours After Diagnosis) and Late (48 Hours or Longer After Diagnosis) Surgery for Internal Herniation

Parameter	Early Surgery (n=12)	Late Surgery (n=21)	*P*
GA at surgery (wk)	31.0 (28.0–33.8)	30.0 (24.5–33.0)	.21
Laparoscopy only	5 (41.7)	6 (28.6)	**.02**
Laparotomy only	3 (25.0)	14 (66.7)	**.02**
Laparoscopy converted to laparotomy	4 (33.3)	1 (4.8)	**.02**
Bowel resection	1 (8.3)	7 (33.3)	.2
Concomitant cesarean delivery	3 (25.0)	8 (38.1)	.7
Maternal death	0 (0)	2 (9.5)	.52
Perinatal death	0 (0)	3 (14.3)	.28

GA, gestational age.
Data are median (interquartile range) or n (%) unless otherwise specified.
Bold indicates $P<.05$.

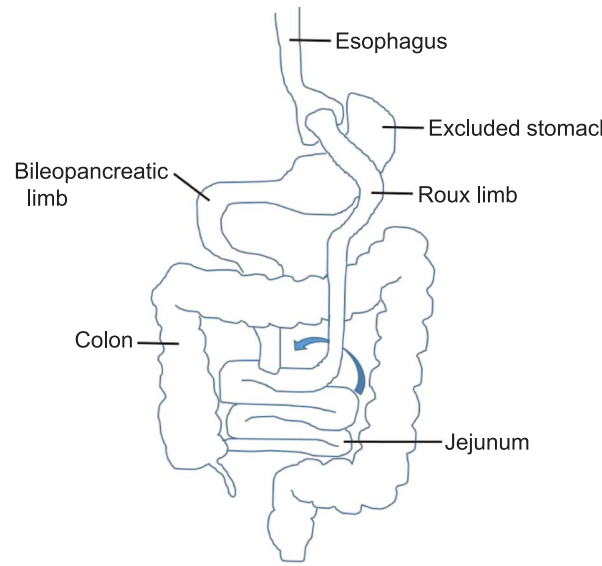

Fig. 2. Abdominal anatomy after Roux-en-Y gastric bypass and site of most common internal herniation. *Arrow* indicates Petersen's hernia.

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a low threshold for imaging and surgical intervention is appropriate. Negative imaging is not entirely reassuring but can be used to narrow the differential diagnosis. A prospective registry of pregnancies after bariatric surgery is currently ongoing (AURORA-trial, ClinicalTrials.gov NCT02515214) and may bring further information on the incidence of internal herniation in pregnancy.

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